Chapter 2.0 1998 Emissions

2.1 WHAT EMISSIONS DATA ARE PRESENTED IN THIS CHAPTER?

This chapter describes the carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compound (VOC), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), lead (Pb), and ammonia (NH_3) emission estimates for 1998. Any notable trends from 1996 levels are discussed.

2.2 HOW HAVE EMISSION ESTIMATES CHANGED FROM 1996 TO 1998 AND WHY?

Tables A-1 through A-7 provide detailed emission summaries for all pollutants at 5-year intervals from 1970 through 1985 and yearly for the period 1988 through 1998. Exact percentage changes from year to year for specific source categories can be calculated from those tables. In particular the tables show that between 1996 and 1998, overall emissions levels for CO and VOC decreased, NO_x remained essentially level, while emissions for SO_2, PM_{10}, and $PM_{2.5}$, and Pb increased. Specifically,

...for utilities

- SO_2 emissions from point sources increased primarily due to coal-fired and oil-fired electric utilities. Increased burning of bituminous and anthracite coal by utilities created an increase of approximately 0.5 million tons/year of SO_2.[1]

...for on-road vehicles

- Reductions due to fleet turnover (implementation of Tier I standards),[2] reformulated gasoline requirements, oxygenated fuel, and fuels with lower Reid vapor pressure resulted in the decrease in on-road CO, NO_x, VOC, PM_{10}, and $PM_{2.5}$ emissions despite the higher vehicle miles traveled (VMT) in 1998.

- Higher VMT caused an increase in SO_2 and NH_3 on-road emissions.

- Changes to 1990-1998 NO_x emissions from heavy-duty diesel vehicles (HDDV) due to adjustments in emissions due to the diesel defeat device (see section 5.7.4).

...for non-road vehicles

- 1998 emissions decreased slightly for CO, NO_x, and VOC, remained steady for Pb, and increased slightly for NO_x, SO_2, PM_{10}, and $PM_{2.5}$ due to variations in fuel consumption by non-road engines[3] (gasoline and diesel) and vehicles (airplanes, locomotives, and marine vessels).

...for miscellaneous sources

- 1998 miscellaneous emissions decreased from 1996 levels for all pollutants except PM_{10}, $PM_{2.5}$, and NH_3. Increases in particulate emissions were primarily the result of increased VMT on paved and unpaved roads, as well as growth in the construction sector due to the strong economy. Increases in NH_3 were primarily an inventory artifact resulting from improved activity data related to agricultural livestock operations.[4]

2.2.1 What Sources Are the Main Contributors to 1998 CO Emissions?

Figure 2-1 is a pie chart showing 1998 CO emissions by source category. As the figure shows:

- On-road vehicles are major contributors to CO emissions, representing 57 percent of total national CO emissions. Of this 57 percent, just over half comes from light-duty gasoline vehicles (LDGVs [primarily cars]) and motorcycles.

- Non-road vehicles and engines contribute slightly more than 20 percent of total CO emissions. These emissions come primarily from gasoline consumption by lawn and garden, industrial, and recreational marine engines.

- Solvent utilization, storage and transport, and electric utility fuel combustion (three Tier 1 source categories) contribute slightly more than 0.5 percent to total national CO emissions. These source categories are combined with petroleum and related industries, industrial fuel combustion, other industrial processes, waste disposal and recycling, and chemical and allied product manufacturing, to create the "all other" grouping in Figure 2-1.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources and some minor point sources, comprise over 95 percent of total 1998 CO emissions.

2.2.2 What Sources Are the Main Contributors to 1998 NO_x Emissions?

Figure 2-2 is a pie chart showing 1998 NO_x emissions by source category. As the figure shows:

- On-road vehicles account for 31 percent of total national NO_x emissions. LDGVs are a major contributor (approximately 37 percent) to the 1998 on-road vehicle NO_x emissions.

- Electric utilities represent 25 percent of total national NO_x emissions in 1998. Coal combustion represents almost 90 percent of these emissions, with two-thirds of the coal combustion emissions coming from bituminous coal combustion.

- Solvent utilization, storage and transport, waste disposal and recycling, and metals processing (four Tier 1 source categories) constitute less that 1 percent of total national NO_x emissions. The United States (U.S.) Environmental Protection Agency (EPA) includes these sources in the "all other" grouping in Figure 2-2, along with chemical and allied product manufacturing, other industrial processes, miscellaneous, and petroleum and related industries.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, comprise 62 percent of total 1998 NO_x emissions. On-road and non-road sources contribute 53 percent of the total NO_x.

2.2.3 What Sources Are the Main Contributors to 1998 VOC Emissions?

Figure 2-3 shows 1998 VOC emissions by source category. As the figure indicates:

- Solvent utilization represents 30 percent of the total 1998 VOC emissions. Surface coating constitutes just over 40 percent of the solvent utilization emissions. The 26 specific subcategories of surface coating estimated by EPA are presented in Table A-3. Table A-3 also shows the effects of control programs on these sources. For example, co-control of VOCs related to maximum achievable control technology (MACT) controls can be seen for 1998 emissions from industrial adhesive surface coating operations. A MACT standard for that source category went into effect in 1998, reducing emissions by over 50 percent relative to 1996 and 1997 values.[5]

- On-road vehicles represented 29 percent of total national VOC emissions. LDGVs account for just over half of total national on-road vehicle VOC emissions.

- Electric utility fuel combustion and metals processing (two Tier 1 source categories) contribute slightly less than 3 percent of total national VOC emissions. EPA combines electric utility fuel combustion, metals processing, chemical and allied product manufacturing, petroleum and related industries, miscellaneous, other industrial processes and fuel combustion (industrial, other) into an "all other" grouping of Figure 2-3. This "all other" grouping contributed 21 percent to the total 1998 VOC emissions.

Table 2-1 presents the point and area source split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 86 percent of total 1998 VOC emissions.

2.2.4 What Sources Are the Main Contributors to 1998 SO_2 Emissions?

Figure 2-4 is a pie chart showing 1998 SO_2 emissions by source category. As the figure shows:

- Electric utilities contribute the majority of SO_2 emissions, representing over two-thirds (68 percent) of total national SO_2 emissions in 1998. Well over 90 percent of these emissions come from coal combustion. Bituminous coal combustion accounts three-fourths of the electric utility coal combustion emissions.

- Industrial coal combustion produced 15 percent of the 1998 SO_2 emissions.

- Solvent utilization, storage and transport, waste disposal and recycling, on-road sources, and miscellaneous (five Tier 1 source categories) account for 2 percent of total national SO_2 emissions. These sources, along with non-road sources, petroleum and related industries, and other industrial processes, comprise EPA's "all other" grouping.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 14 percent of total 1998 SO_2 emissions, while point sources make up the remainder.

2.2.5 What Sources Are the Main Contributors to 1998 Particulate Matter (PM_{10} and $PM_{2.5}$) Emissions?

Figures 2-5 and 2-6 are pie charts showing 1998 PM_{10} and $PM_{2.5}$ emissions by source category. They depict the nonfugitive dust sources of PM_{10} and $PM_{2.5}$. As the figures show:

- Fuel combustion processes (utilities, industrial, commercial, and institutional boilers, and area source combustion) contribute the most to the nonfugitive dust portions of PM. Mobile sources, both on-road and non-road, are the next largest category of emitters. Industrial processes collectively comprise only about 10 percent of the nonfugitive dust sources, but they could have a significant effect on air quality in their vicinity.

- Wildfire PM_{10} and $PM_{2.5}$ emissions for 1998 decreased significantly relative to 1996 and 1997 levels due to a dramatic reduction in the number of acres burned. Managed burning and wildfires comprise most of the area source combustion contributions in Figures 2-5 and 2-6.

Although the NET inventory shows that fugitive dust contributes a large percentage to the total PM emissions, a report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, availability of horizontal and vertical surfaces for impaction and initial suspension energy. This is consistent with the generally small amount of crustal materials found on speciated ambient samples.[6]

For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the U.S.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 96 percent of total 1998 PM_{10} emissions. Methods and related data sources for several area source categories are currently being reviewed. These include unpaved roads, open burning, and construction.

Note that some emission estimates have not been updated. For example, wind erosion particulate emissions have been maintained at a constant value since 1996. Also, annual estimates of wind erosion emissions are difficult to interpret, owing to the extremely short duration of most wind events.

2.2.6 What Sources Are the Main Contributors to 1998 Pb Emissions?

Figure 2-7 is a pie chart showing 1998 Pb emissions by source category. As the figure shows:

- Metals processing contributes 53 percent to total national Pb emissions. Nonferrous metal processing represents 65 percent of the 1998 metals processing emissions. Primary and secondary Pb products represent 46 and 37 percent, respectively, of the nonferrous metals in 1998.

- On-road emissions account for less than 0.5 percent of total national Pb emissions.

- EPA does not estimate Pb emissions for the following 5 Tier 1 source categories because Pb emissions from these sources are thought to be negligible: solvent utilization, storage and transport, petroleum and related industries, natural sources, and miscellaneous. Figure 2-7 shows the percentage contribution from the remaining 9 Tier 1 categories. The "all other" grouping includes chemical and allied product manufacturing, other industrial processes, and fuel combustion (electric utility and industrial).

2.2.7 What Sources Are the Main Contributors to 1998 NH_3 Emissions?

Figure 2-8 is a pie chart showing 1998 NH_3 emissions by source category. As the figure shows, livestock agriculture contributes the largest amount of NH_3 emissions. Livestock agriculture and fertilizer application combined comprise 86 percent of total national NH_3 emissions in 1998. Currently, the USDA and EPA are working to refine the NH_3 inventory for all source categories, including some natural and biogenic categories that are not in the current inventory. As mentioned above (section 2.2.5), NH_3 is involved in the formation of ammonium sulfate and ammonium nitrate particles. The NH_3 inventory is important to perform modeling simulations to understand the formation of these particles in the atmosphere using transport and transformation models.

2.3 HOW DOES EPA ESTIMATE AND REPORT SPATIAL EMISSIONS?

EPA estimates emissions at the county level and then sums them to the state level for all criteria pollutants except Pb and for all source categories except fugitive dust sources and wildfires (whose emissions are estimated at the State level and are allocated to the county level using spatial surrogates). Figures 2-9 through 2-15 present the broad geographic distributions of 1998 emissions based on each county's tonnage per square mile. Specifically,

- Figure 2-9 shows that (on an emission density basis) the eastern third of the United States and the west coast emit more CO than the western two-thirds of the continental United States.

- Figures 2-10 through 2-12 show that the eastern half of the United States and the west coast emit more NO_x, VOC, and SO_2 than the western half of the continental United States.

- Fugitive dust emissions, which predominate in rural and agricultural areas, comprise the major component of PM_{10} and $PM_{2.5}$ emissions. NH_3 emissions follow a similar pattern, although they are primarily associated with agricultural and fertilizer sources rather than fugitive dust.

2.3.1 How Does My State Compare in Rank to Other States?

To understand how a particular State ranks relative to magnitude of emissions, refer to Table 2-2, which presents the total state-level emissions and state rankings for all pollutants.

- EPA summed the county-level emissions to produce the state-level emissions.

- The estimates for Alaska and Hawaii include only on-road vehicle, point source, residential wood combustion, and wildfire emissions. PM_{10} and $PM_{2.5}$ estimates also include some fugitive dust estimates for Alaska and Hawaii. (A base year inventory similar to National Acid Precipitation Assessment Program (NAPAP) was not available for these states.)

2.4 WHAT ARE THE LARGEST POINT SOURCES IN THE INVENTORY?

Refer to Table 2-1 to understand which categories contain the largest amount of point sources. Historically, steel mills, smelters, utility plants, and petroleum refining produce the largest point source emissions. We usually provide point source top 50 lists in this report; however, this year new periodic emission inventory (PEI) point source data was received and was still being quality assured at press time. Once the State data is deemed accurate, EPA intends to post top 50 lists by pollutant on EPA's Emission Factor and Inventory Group's (EFIG) web site (expected later in 2000). The internet address for the EFIG is: **http://www.epa.gov/ttn/chief/efig**.

2.5 REFERENCES

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2. Federal Register as 56 FR 25724, June 5, 1991.
3. **http://www.epa.gov/otaq/nonrdmdl.htm**
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5. Listing of MACT rules may be found at: **http://www.epa.gov/ttn/uatw/eparules.html**
6. Watson, John G. and Judith C. Chow, "Reconciling Urban Fugitive Dust Emissions Inventory and Ambient Source Contribution Estimates: Summary of Current Knowledge and Recent Research" DRAFT, Desert Research Institute Document No. 61104dD2, Reno, NV, September 3, 1999. (This document may be found at: **http//www.epa.gov/ttn/chief/ap42pdf/fugitive.pdf**).
7. "National Air Quality and Emission Trends Report, 1997", EPA-454/R-98-016, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Pages 42-45, December 1998.
8. "National Air Pollutant Emissions Trends, 1900-1996," EPA-454/R-97-011, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1997.
9. Bollman, A.D. and G. Stella, "Status and Future Plans for the Economic Growth Analysis System (EGAS)." Proceedings of the Air & Waste Management Association Emission Inventory Specialty Conference, New Orleans, LA, December 8-10, 1998.

Table 2-1. 1998 National Point and Area Emissions by Source Category and Pollutant (thousand short tons)

	CO			NO_x			VOC			SO_2		
Source Category	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
FUEL COMB. ELEC. UTIL.	413	4	417	6,095	8	6,103	54	0	54	13,217	0	13,217
FUEL COMB. INDUSTRIAL	908	206	1,114	2,142	827	2,969	144	17	161	2,075	820	2,895
FUEL COMB. OTHER	83	3,760	3,843	142	975	1,117	12	666	678	191	418	609
CHEMICAL & ALLIED PRODUCT MFG	1,129	0	1,129	152	0	152	312	84	396	299	0	299
METALS PROCESSING	1,494	1	1,495	88	0	88	75	0	76	444	0	444
PETROLEUM & RELATED INDUSTRIES	365	3	368	122	16	138	223	273	496	344	0	345
OTHER INDUSTRIAL PROCESSES	629	3	632	402	6	408	388	62	450	366	3	370
SOLVENT UTILIZATION	2	0	2	2	0	2	639	4,640	5,278	1	0	1
STORAGE & TRANSPORT	80	0	80	7	0	7	298	1,025	1,324	3	0	3
WASTE DISPOSAL & RECYCLING	31	1,123	1,154	38	59	97	27	406	433	19	24	42
HIGHWAY VEHICLES	0	50,386	50,386	0	7,765	7,765	0	5,325	5,325	0	326	326
OFF-HIGHWAY	0	19,914	19,914	0	5,280	5,280	0	2,461	2,461	0	1,084	1,084
NATURAL SOURCES	0	0	0	0	0	0	0	14	14	0	0	0
MISCELLANEOUS	0	8,920	8,920	1	327	328	2	770	772	0	12	12
TOTAL	**5,134**	**84,319**	**89,454**	**9,190**	**15,264**	**24,454**	**2,174**	**15,743**	**17,917**	**16,960**	**2,688**	**19,647**

Emissions (percent)

	CO			NO_x			VOC			SO_2		
Source Category	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
FUEL COMB. ELEC. UTIL.	8	0	0	66	0	25	2	0	0	78	0	67
FUEL COMB. INDUSTRIAL	18	0	1	23	5	12	6	0	1	12	31	15
FUEL COMB. OTHER	2	4	4	2	6	5	0	4	4	1	16	3
CHEMICAL & ALLIED PRODUCT MFG	22	0	1	2	0	1	12	1	2	2	0	2
METALS PROCESSING	29	0	2	1	0	0	18	0	2	3	0	2
PETROLEUM & RELATED INDUSTRIES	7	0	0	1	0	1	9	2	3	2	0	2
OTHER INDUSTRIAL PROCESSES	12	0	1	4	0	2	15	0	2	2	0	2
SOLVENT UTILIZATION	0	0	0	0	0	0	25	29	29	0	0	0
STORAGE & TRANSPORT	2	0	0	0	0	0	12	7	7	0	0	0
WASTE DISPOSAL & RECYCLING	1	1	1	0	0	0	1	3	2	0	1	0
HIGHWAY VEHICLES	0	60	56	0	51	32	0	34	29	0	12	2
OFF-HIGHWAY	0	24	22	0	35	22	0	16	13	0	40	6
NATURAL SOURCES	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	0	11	10	0	2	1	0	5	4	0	0	0
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100

Table 2-1 (continued)

Source Category	PM$_{10}$ Point	PM$_{10}$ Area	PM$_{10}$ Total	PM$_{2.5}$ Point	PM$_{2.5}$ Area	PM$_{2.5}$ Total	NH$_3$ Point	NH$_3$ Area	NH$_3$ Total
FUEL COMB. ELEC. UTIL.	302	0	302	165	0	165	8	0	8
FUEL COMB. INDUSTRIAL	201	45	245	147	13	160	40	7	47
FUEL COMB. OTHER	18	526	544	11	455	466	0	6	6
CHEMICAL & ALLIED PRODUCT MFG	65	0	65	39	0	39	165	0	165
METALS PROCESSING	170	0	171	112	0	112	5	0	5
PETROLEUM & RELATED INDUSTRIES	31	1	32	18	0	18	35	0	35
OTHER INDUSTRIAL PROCESSES	299	40	339	168	19	187	4	40	44
SOLVENT UTILIZATION	6	0	6	5	0	5	0	0	0
STORAGE & TRANSPORT	94	0	94	32	0	32	1	0	1
WASTE DISPOSAL & RECYCLING	13	297	310	9	230	238	0	86	86
HIGHWAY VEHICLES	0	257	257	0	197	197	0	250	250
OFF-HIGHWAY	0	461	461	0	413	413	0	10	10
NATURAL SOURCES	0	5,307	5,307	0	796	796	0	34	34
MISCELLANEOUS	34	26,576	26,609	22	5,527	5,549	0	4,244	4,244
TOTAL	**1,232**	**33,509**	**34,741**	**729**	**7,650**	**8,379**	**259**	**4,677**	**4,936**

Emissions (percent)

Source Category	PM$_{10}$ Point	PM$_{10}$ Area	PM$_{10}$ Total	PM$_{2.5}$ Point	PM$_{2.5}$ Area	PM$_{2.5}$ Total	NH$_3$ Point	NH$_3$ Area	NH$_3$ Total
FUEL COMB. ELEC. UTIL.	25	0	1	23	0	2	3	0	0
FUEL COMB. INDUSTRIAL	16	0	1	20	0	2	16	0	1
FUEL COMB. OTHER	1	2	2	2	6	6	0	0	0
CHEMICAL & ALLIED PRODUCT MFG	5	0	0	5	0	0	64	0	3
METALS PROCESSING	14	0	0	15	0	1	2	0	0
PETROLEUM & RELATED INDUSTRIES	3	0	0	2	0	0	14	0	1
OTHER INDUSTRIAL PROCESSES	24	0	1	23	0	2	2	1	1
SOLVENT UTILIZATION	0	0	0	1	0	0	0	0	0
STORAGE & TRANSPORT	8	0	0	4	0	0	0	0	0
WASTE DISPOSAL & RECYCLING	1	1	1	1	3	3	0	2	2
HIGHWAY VEHICLES	0	1	1	0	3	2	0	5	5
OFF-HIGHWAY	0	1	1	0	5	5	0	0	0
NATURAL SOURCES	0	16	15	0	10	10	0	1	1
MISCELLANEOUS	3	79	77	3	72	66	0	91	86
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-2. Anthropogenic 1998 State-level Emissions and Rank for CO, NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$, and NH_3
(thousand short tons)

State	Rank	CO	Rank	NO_x	Rank	VOC	Rank	SO_2	Rank	PM_{10}	Rank	$PM_{2.5}$	Rank	NH_3
Alabama	12	2,361	15	619	16	419	9	764	19	619	15	184	24	88
Alaska	13	2,249	44	99	14	457	50	12	39	274	19	155	51	1
Arizona	27	1,370	23	450	26	281	26	225	36	336	24	145	36	35
Arkansas	31	1,147	35	267	32	223	36	125	23	529	25	132	10	161
California	1	8,072	2	1,456	2	1,215	28	182	3	1,973	3	535	7	211
Colorado	29	1,200	25	400	27	274	35	137	24	518	29	126	15	111
Connecticut	37	793	41	153	35	156	41	66	45	119	45	30	45	8
DC	51	100	51	23	51	22	51	11	51	6	51	2	50	2
Delaware	50	216	47	77	48	51	37	96	48	39	48	14	43	12
Florida	3	5,203	5	1,059	3	891	6	1,008	11	822	7	260	22	94
Georgia	4	3,998	12	730	9	576	13	660	7	1,103	4	320	17	106
Hawaii	47	321	48	59	47	53	47	35	49	35	49	11	47	7
Idaho	34	956	43	116	39	115	46	39	14	678	17	161	27	78
Illinois	9	2,890	4	1,076	6	748	4	1,153	9	1,028	6	261	11	148
Indiana	11	2,526	7	848	12	518	3	1,164	17	641	20	154	18	104
Iowa	33	1,045	30	343	31	239	23	283	20	602	27	130	2	305
Kansas	28	1,230	20	479	30	257	30	163	4	1,570	5	299	4	232
Kentucky	26	1,389	14	682	23	330	10	753	35	345	35	103	21	95
Louisiana	14	2,184	9	825	15	425	16	405	27	441	23	149	13	130
Maine	42	488	45	94	40	109	44	53	42	158	36	102	46	8
Maryland	32	1,107	29	344	33	183	19	339	41	227	42	57	38	28
Massachusetts	30	1,188	31	304	29	264	24	264	38	290	40	72	42	14
Michigan	7	3,309	6	880	4	765	14	628	21	569	21	153	29	70
Minnesota	22	1,552	21	476	19	381	31	162	10	1,011	10	222	8	198
Mississippi	25	1,414	28	353	24	304	21	305	26	458	26	130	23	91
Missouri	19	1,816	16	546	20	360	15	482	5	1,286	8	252	6	221
Montana	39	703	39	176	42	105	42	60	6	1,137	12	216	19	96
Nebraska	40	681	36	239	36	154	38	94	18	632	30	125	3	241
Nevada	41	520	40	157	43	98	40	66	44	143	44	39	40	17
New Hampshire	45	355	46	82	45	74	34	148	47	54	47	17	48	3
New Jersey	24	1,454	22	466	17	408	25	257	37	313	37	96	41	15
New Mexico	36	855	32	279	38	140	27	199	1	4,987	1	781	34	49
New York	6	3,337	13	723	5	753	12	688	12	767	11	222	30	69
North Carolina	10	2,773	11	745	8	605	11	729	25	501	16	172	9	183
North Dakota	43	380	37	235	41	105	20	327	29	430	38	92	26	79
Ohio	5	3,934	3	1,198	7	706	1	1,921	16	658	13	195	16	111
Oklahoma	23	1,518	24	440	25	295	32	157	8	1,033	14	193	5	222
Oregon	18	1,988	33	271	28	272	43	58	13	686	9	224	31	65
Pennsylvania	8	2,909	8	840	10	575	2	1,221	22	547	18	156	20	96
Rhode Island	49	221	50	35	49	49	49	12	50	25	50	8	49	2
South Carolina	20	1,638	26	367	22	334	22	290	30	410	34	112	37	33
South Dakota	46	333	42	119	44	78	45	53	34	349	39	73	12	132
Tennessee	16	2,037	10	761	11	528	7	789	33	375	28	130	25	83
Texas	2	5,644	1	2,140	1	1,388	5	1,096	2	3,655	2	733	1	511
Utah	35	942	38	233	34	161	39	79	40	238	41	69	35	36
Vermont	48	240	49	46	50	44	48	16	46	75	46	18	44	10
Virginia	15	2,149	17	532	13	471	18	373	31	409	32	118	28	73
Washington	17	2,035	27	364	21	347	33	155	28	430	22	149	32	59
West Virginia	38	721	18	500	37	141	8	787	43	152	43	50	39	19
Wisconsin	21	1,600	19	480	18	400	17	378	32	391	33	112	14	124
Wyoming	44	361	34	270	46	68	29	179	15	663	31	122	33	53
National		**89,454**		**24,454**		**17,917**		**19,647**		**34,741**		**8,379**		**4,935**

Note(s): The sums of States may not equal National totals due to rounding.

Figure 2-1. 1998 National CARBON MONOXIDE Emissions by Principal Source Categories

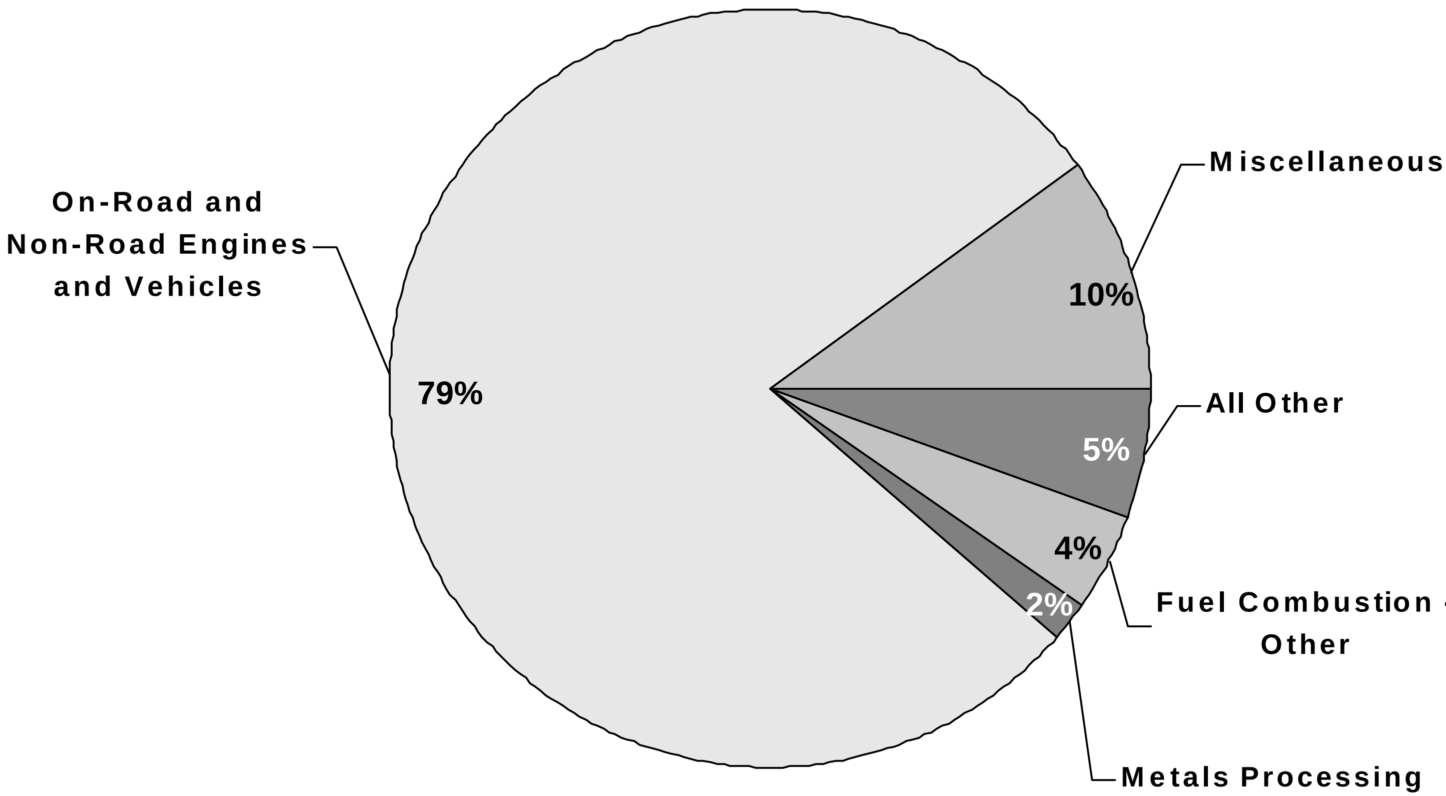


Figure 2-2. 1998 National NITROGEN OXIDE Emissions by Principal Source Categories

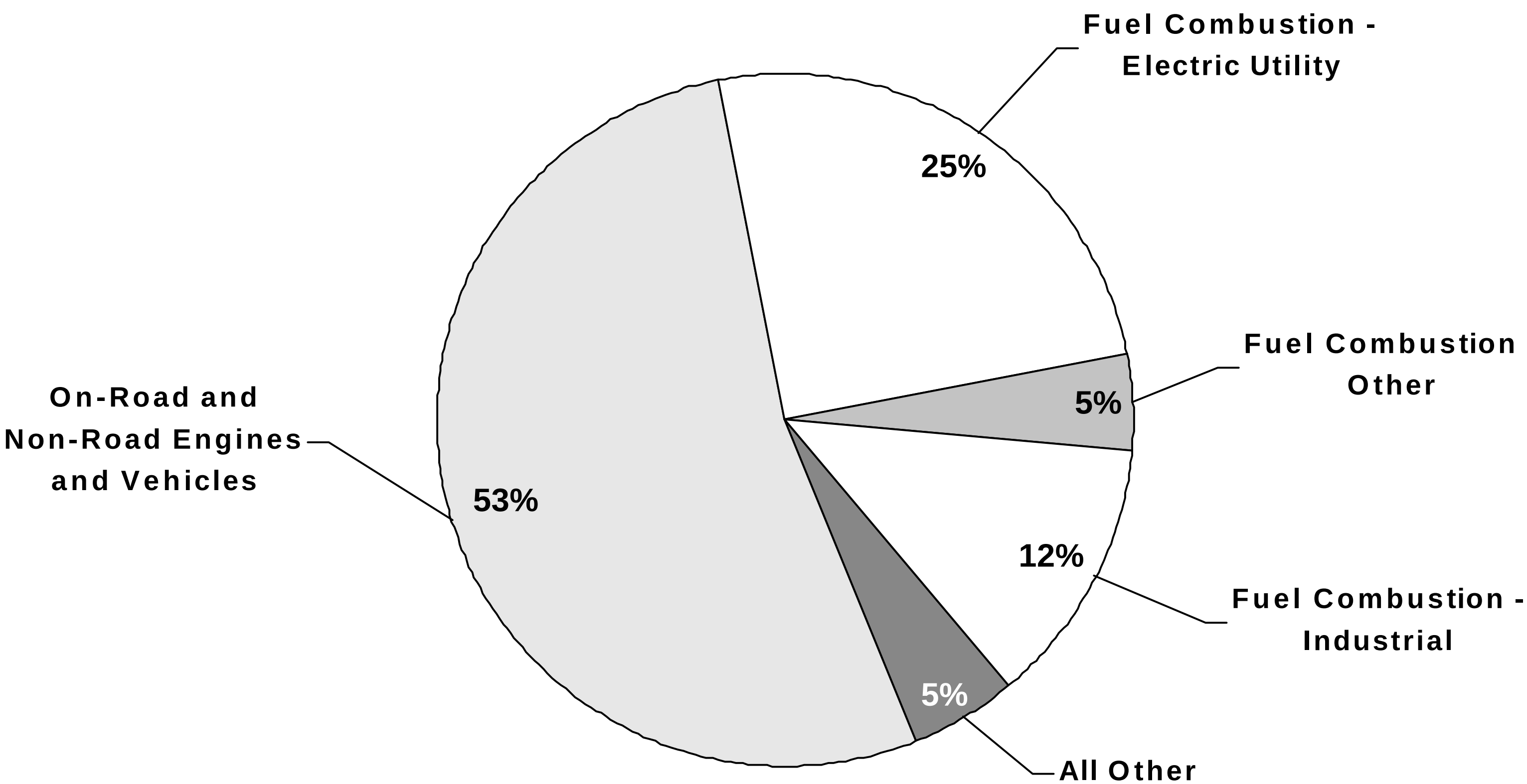


Figure 2-3. 1998 National VOLATILE ORGANIC COMPOUND Emissions by Principal Source Categories

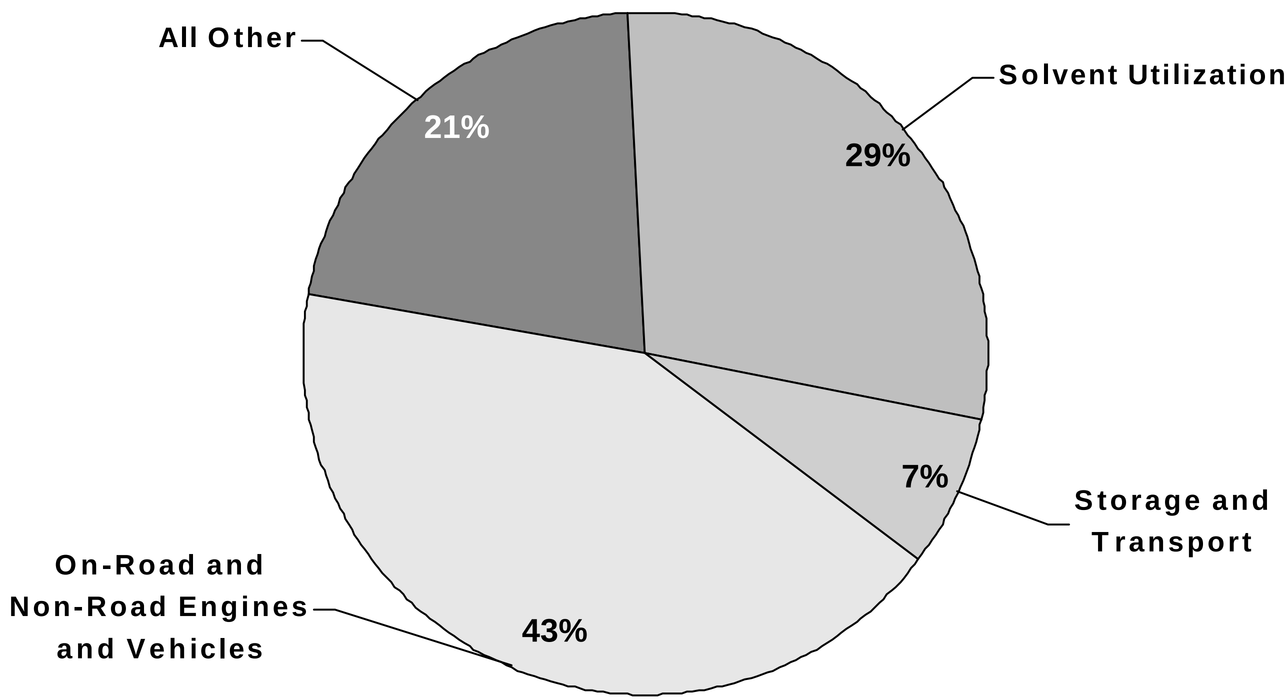


Figure 2-4. 1998 National SULFUR DIOXIDE Emissions by Principal Source Categories

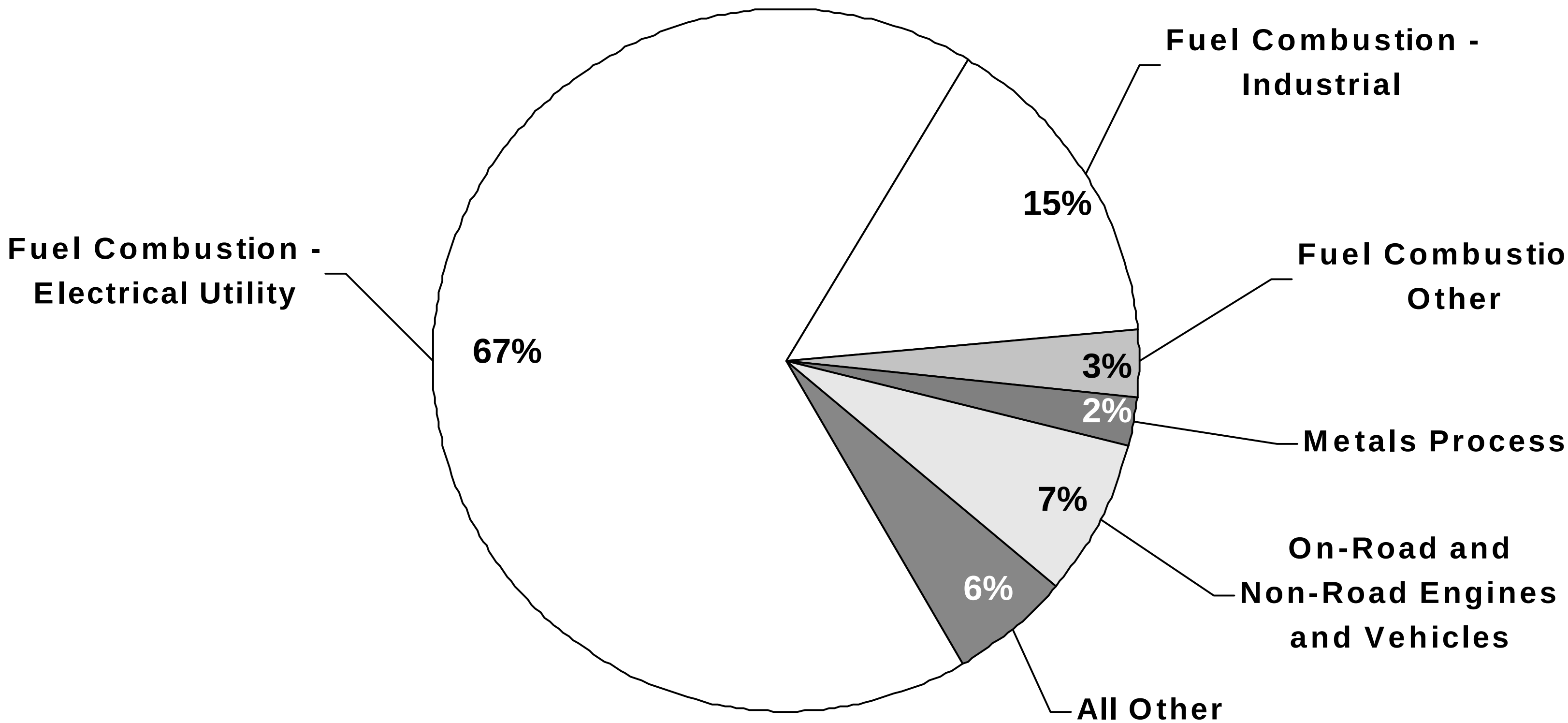
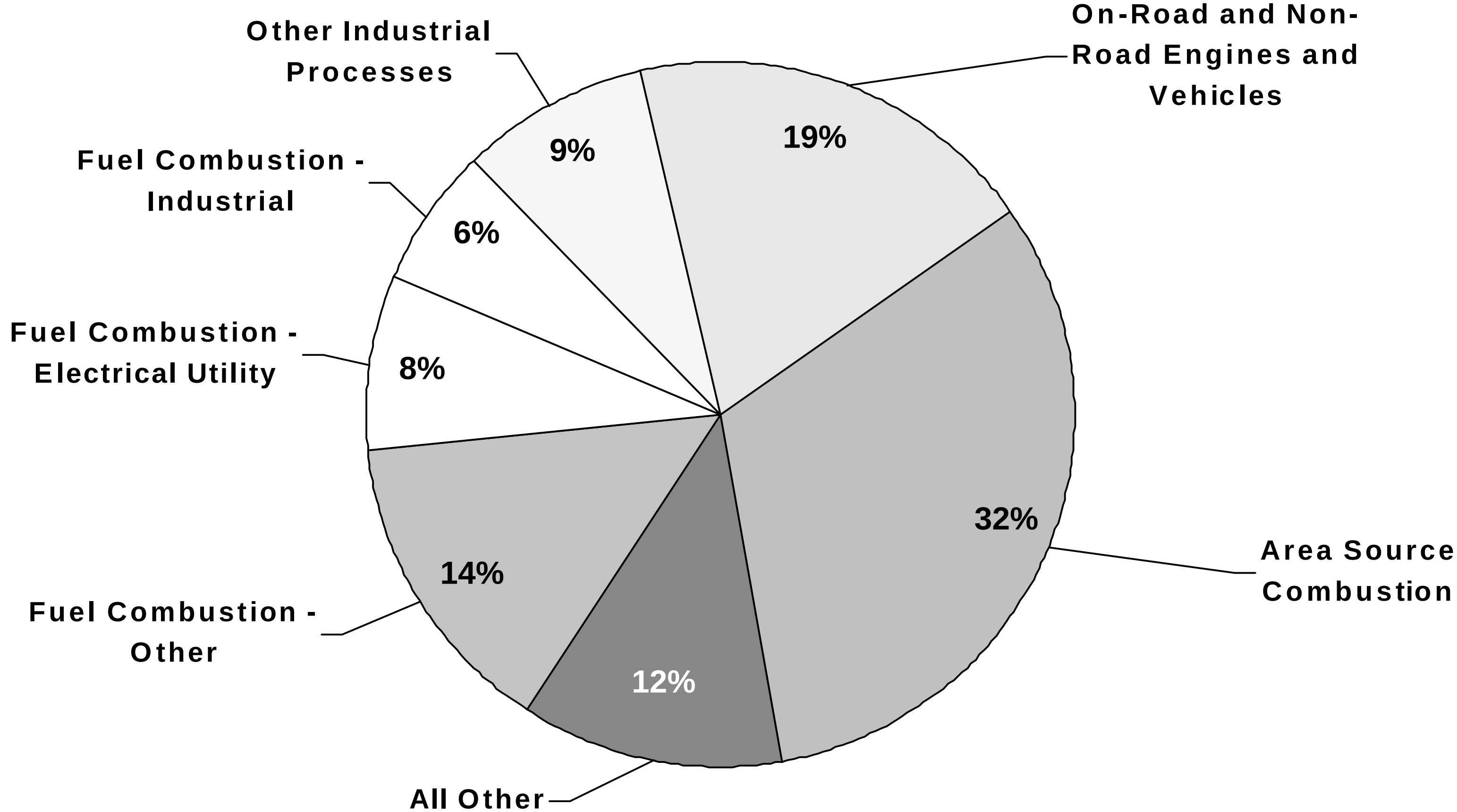
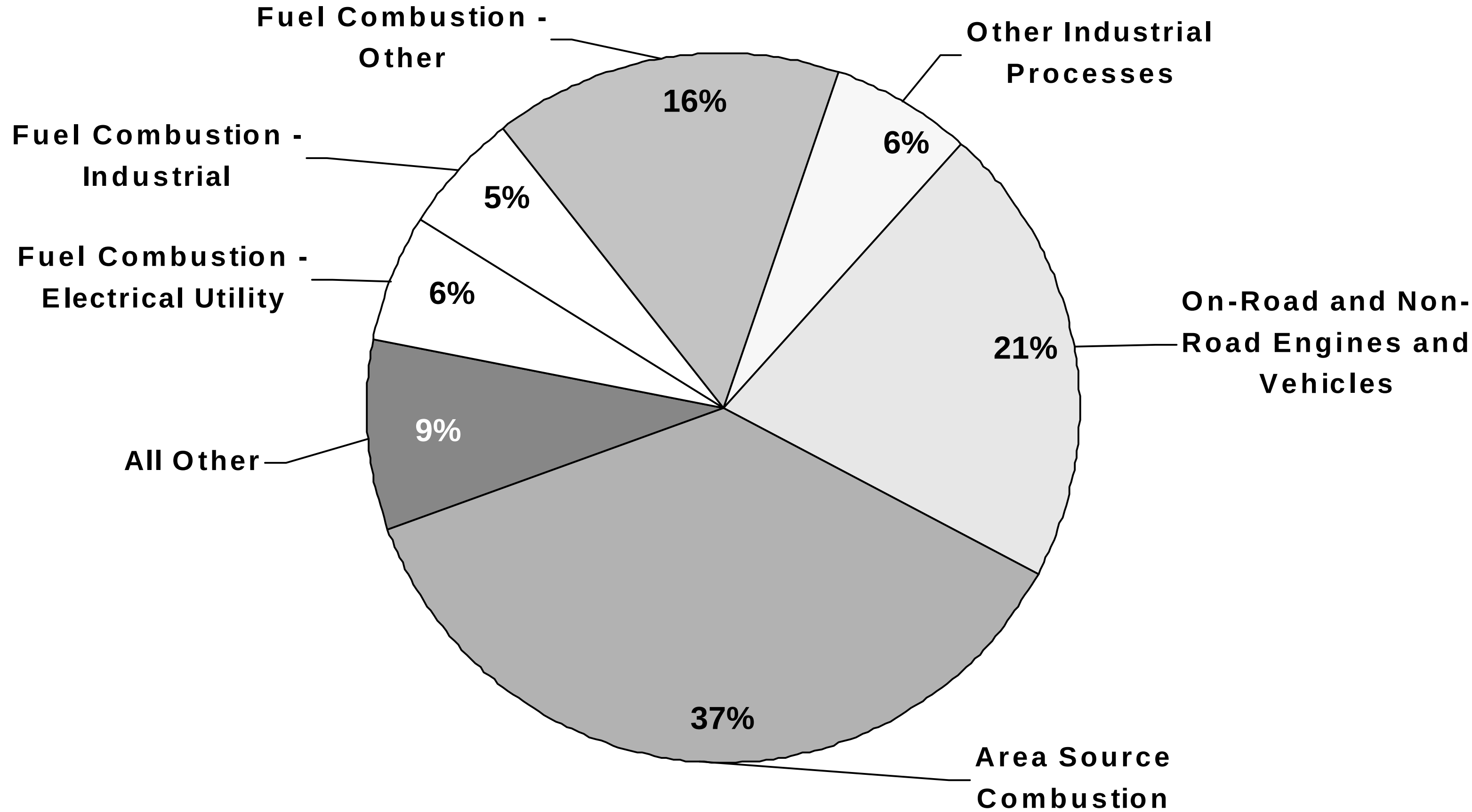


Figure 2-5. 1998 Directly Emitted National PARTICULATE MATTER (PM_{10}) Emissions by Principal Source Categories for Nonfugitive Dust Sources



For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the United States.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM. Note that emissions from fugitive dust sources are not included in the figure.

Figure 2-6. 1998 Directly Emitted National PARTICULATE MATTER ($PM_{2.5}$) Emissions by Principal Source Categories for Nonfugitive Dust Sources



For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the United States.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM. Note that emissions from fugitive dust sources are not included in the figure.

Figure 2-7. 1998 National LEAD Emissions by Principal Source Categories

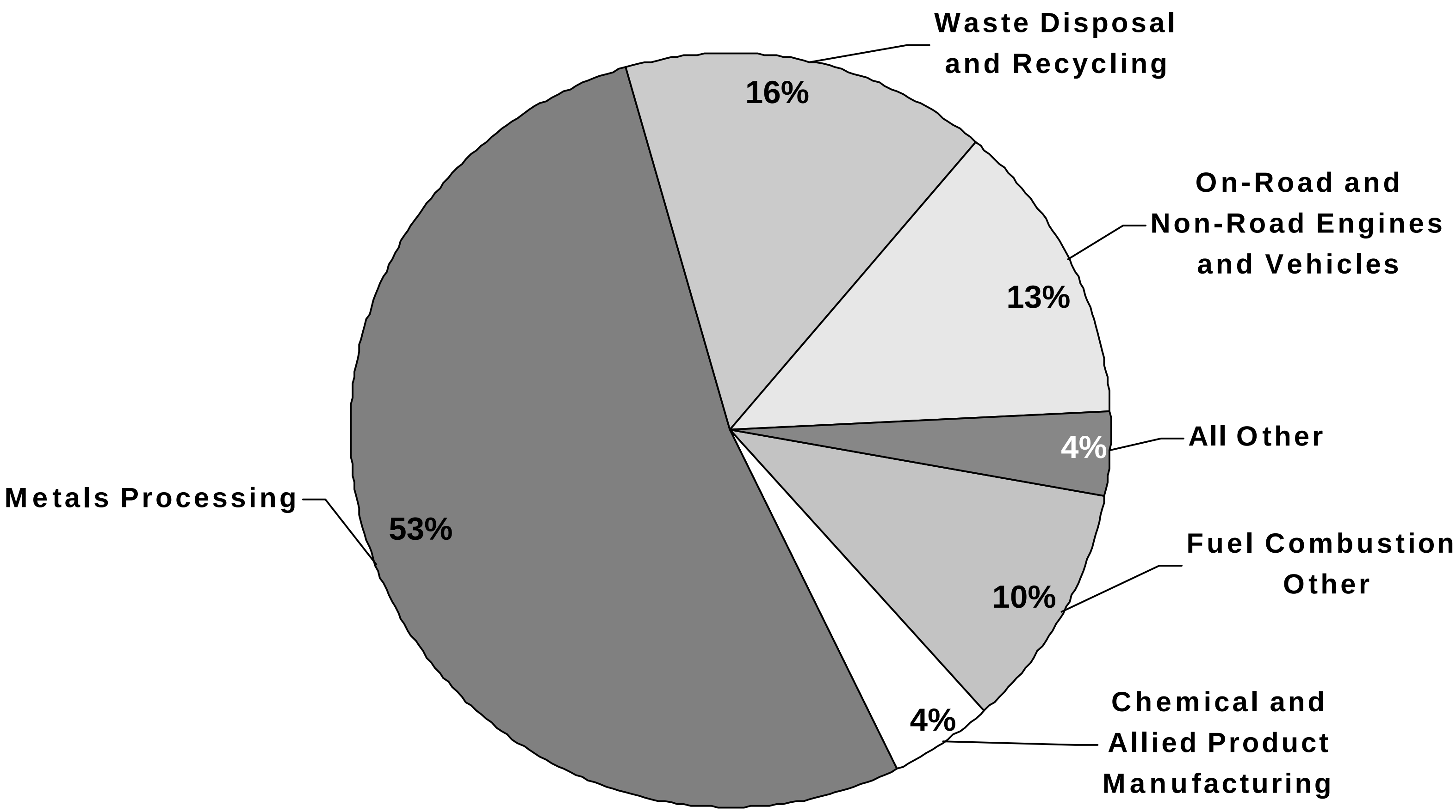


Figure 2-8. 1998 National AMMONIA Emissions by Principal Source Categories

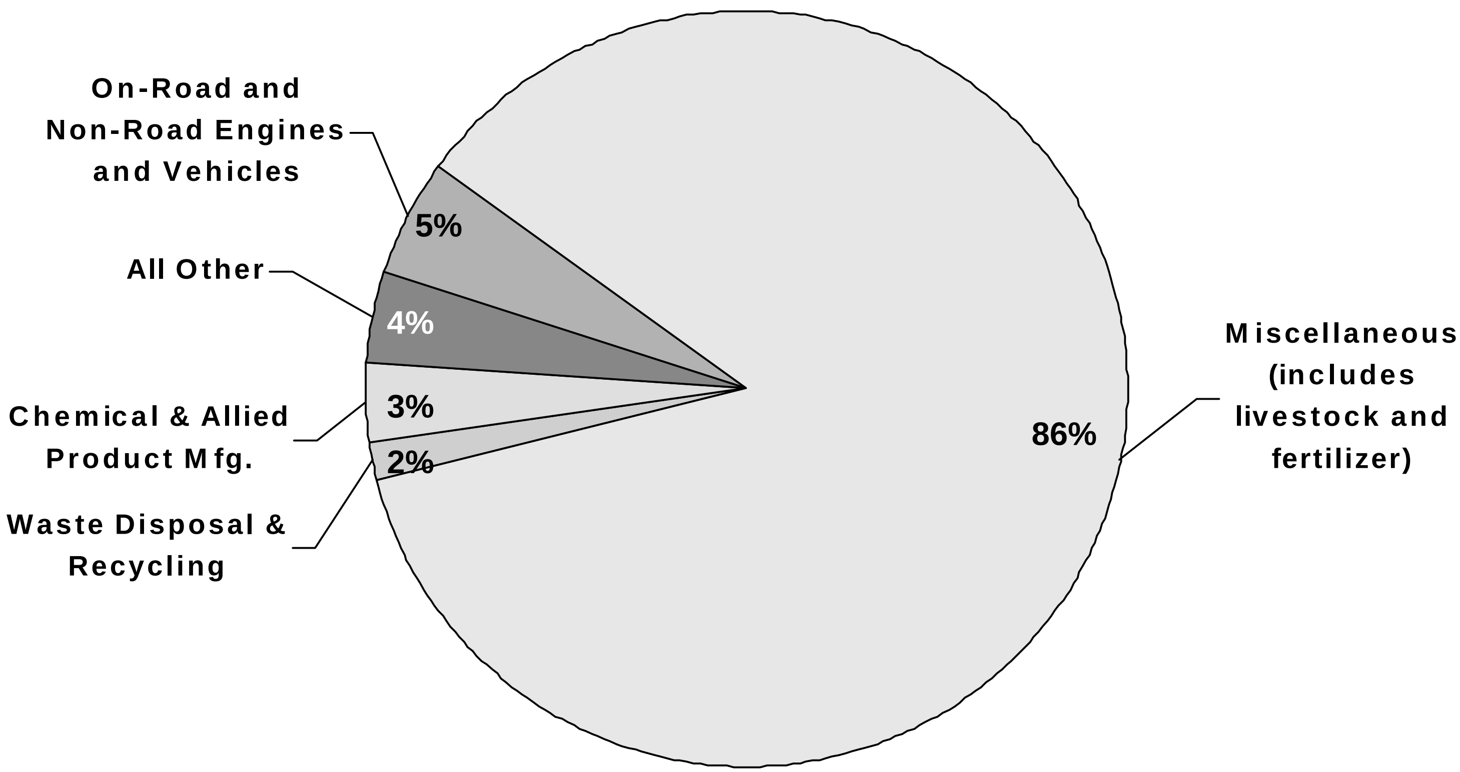


Figure 2-9. Density Map of 1998 CARBON MONOXIDE Emissions by County

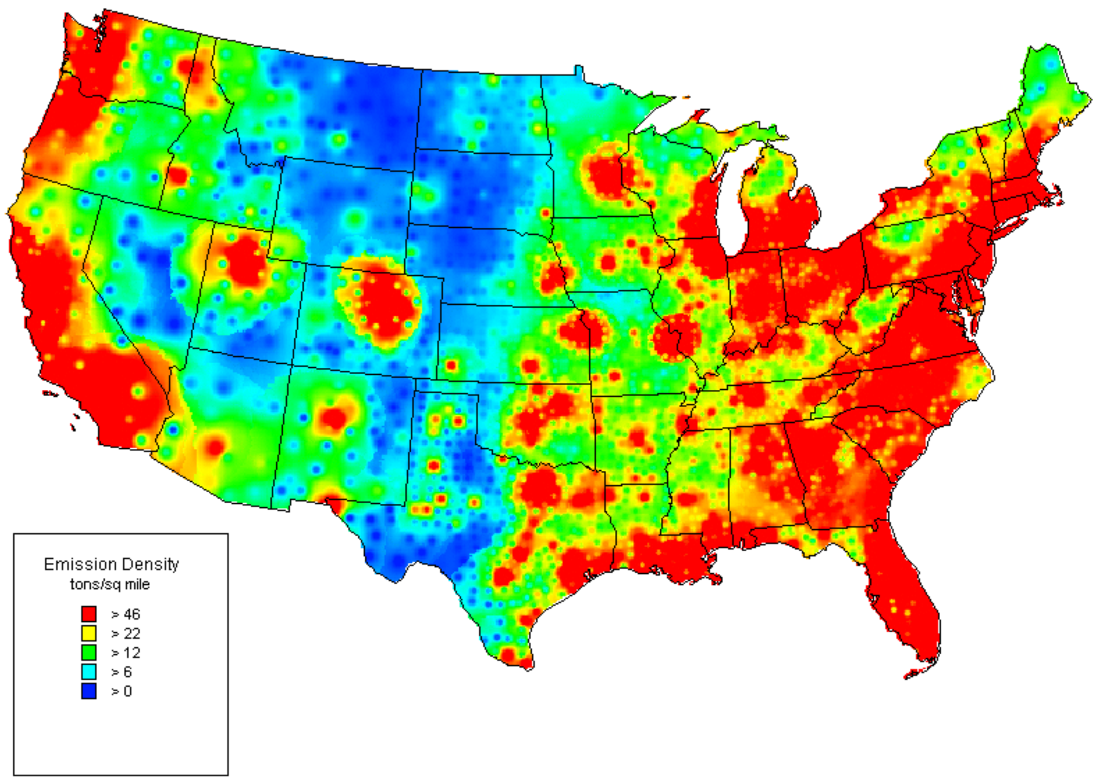


Figure 2-10. Density Map of 1998 NITROGEN OXIDE Emissions by County

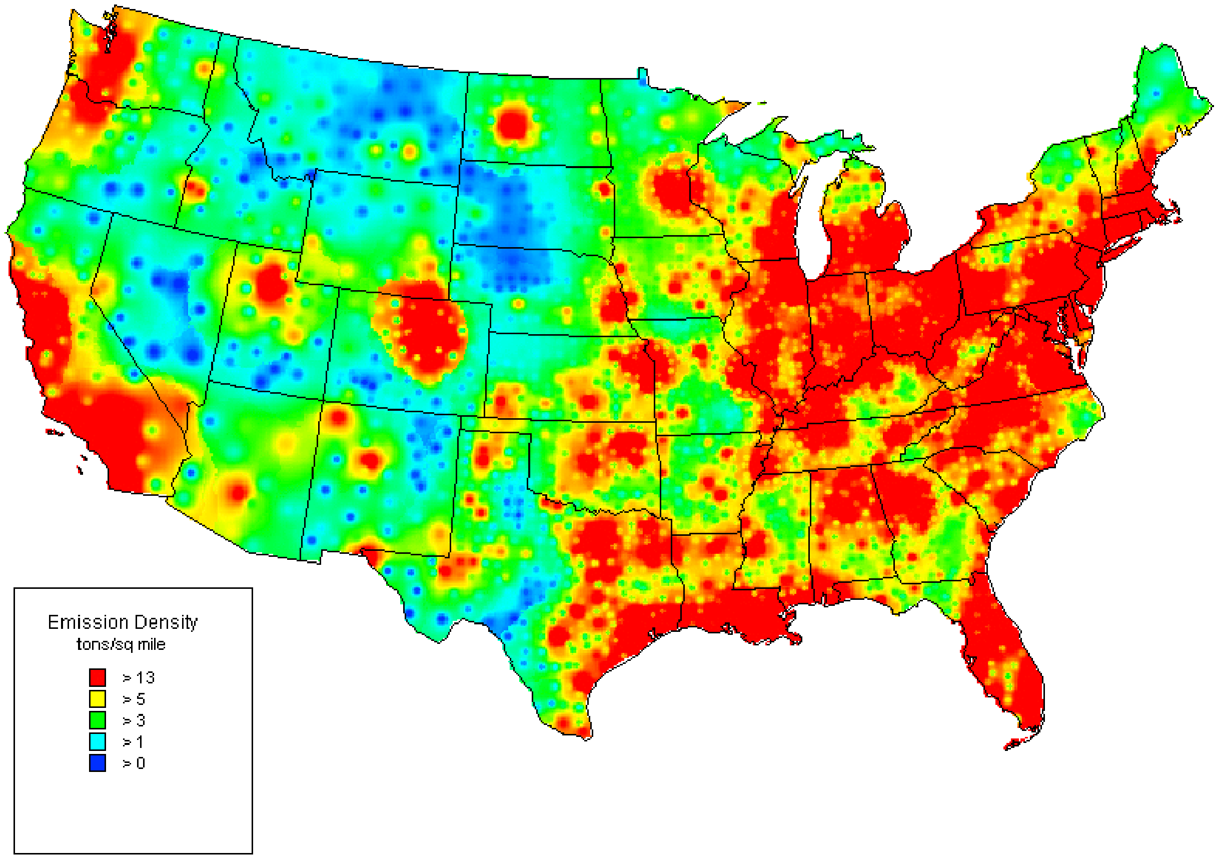


Figure 2-11. Density Map of 1998 VOLATILE ORGANIC COMPOUND Emissions by County

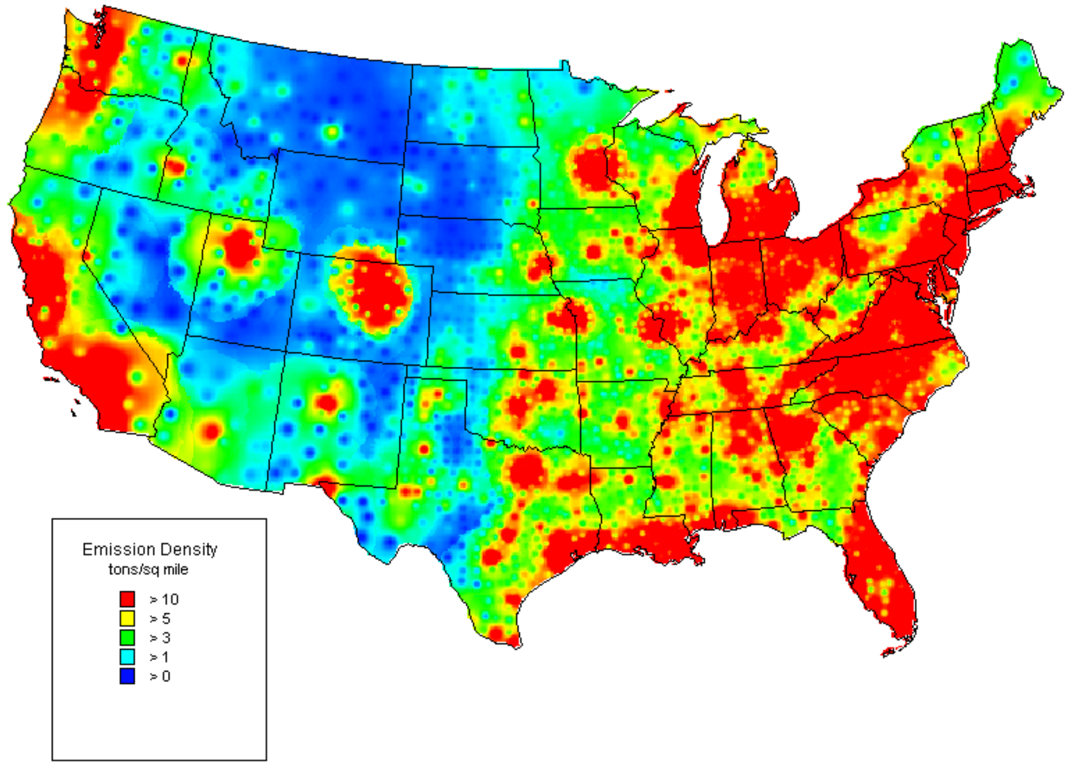


Figure 2-12. Density Map of 1998 SULFUR DIOXIDE Emissions by County

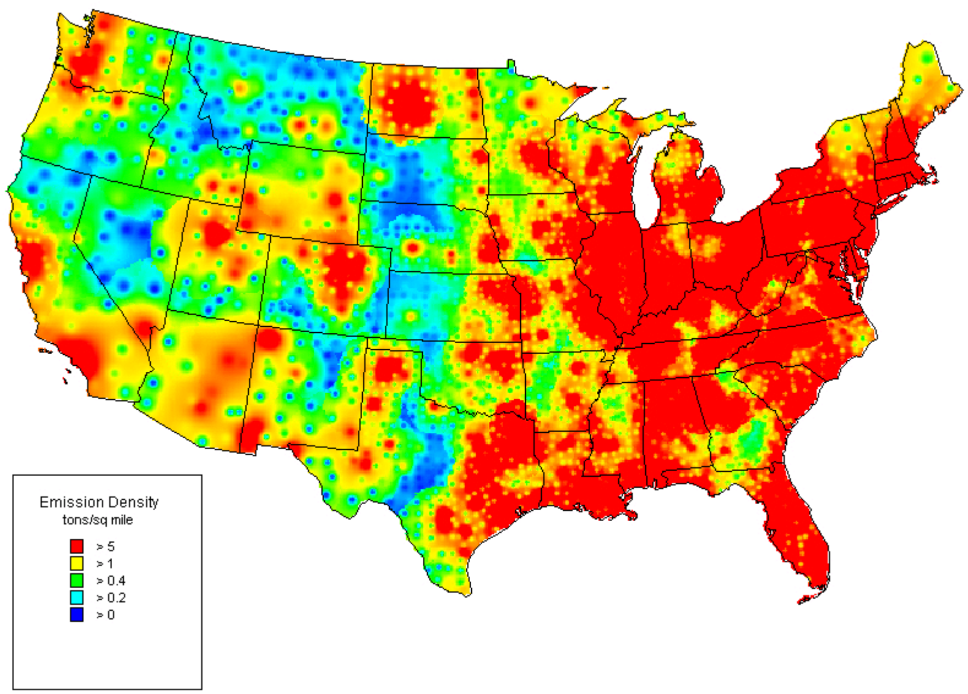


Figure 2-13. Density Map of 1998 PARTICULATE MATTER (PM_{10}) Emissions by County

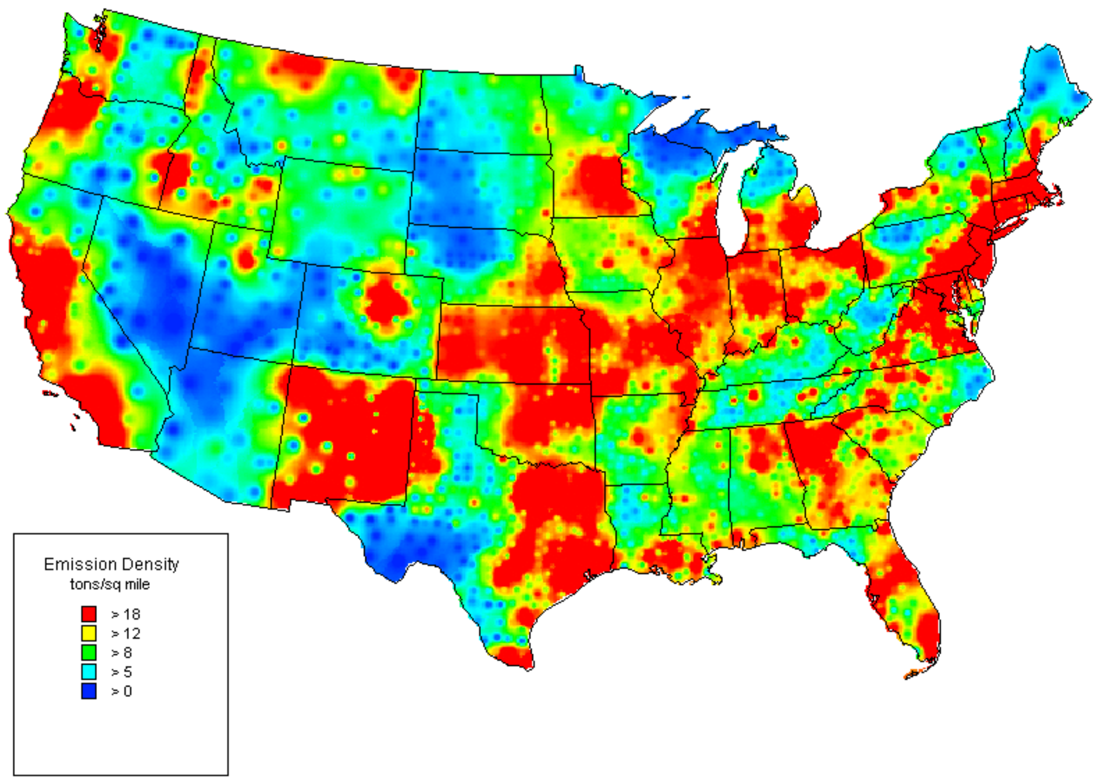


Figure 2-14. Density Map of 1998 PARTICULATE MATTER ($PM_{2.5}$) Emissions by County

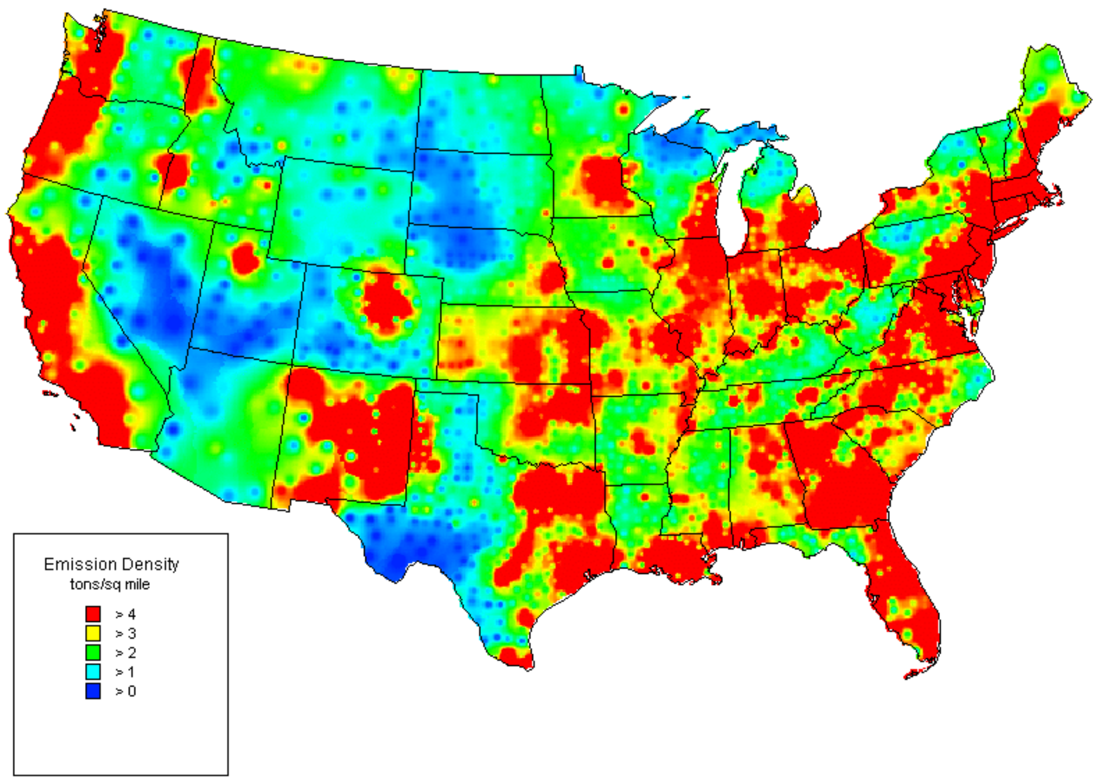
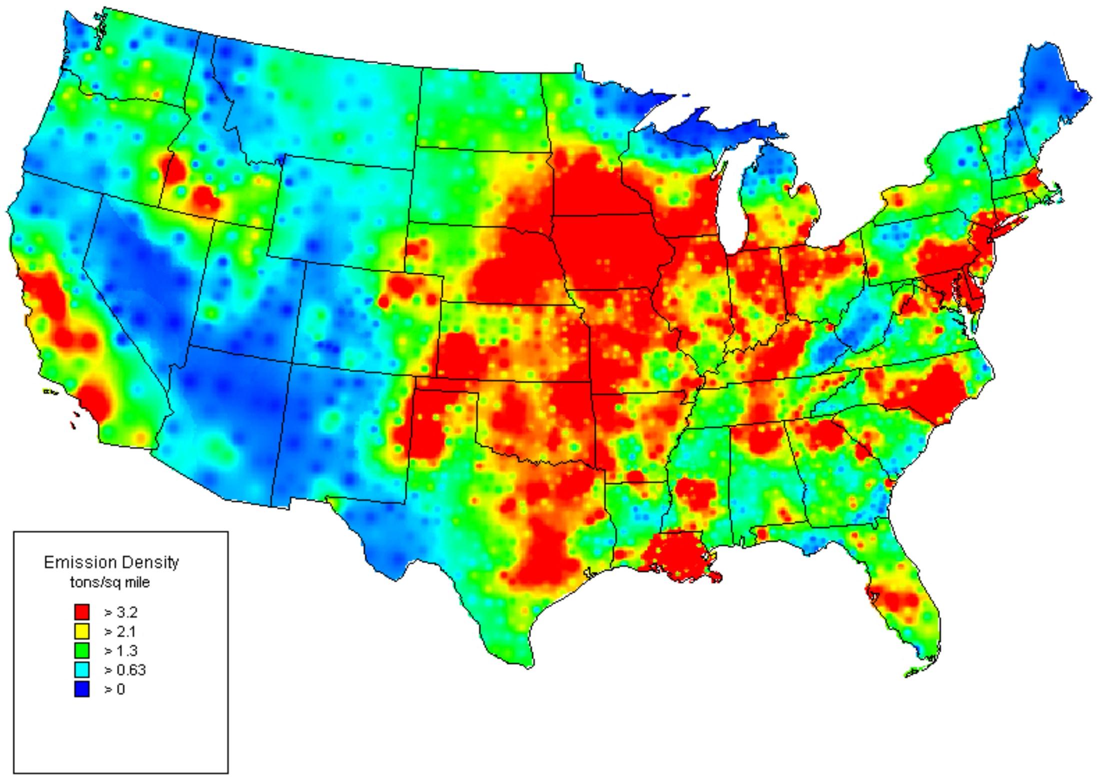


Figure 2-15. Density Map of 1998 AMMONIA Emissions by County



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